be allowable if rewritten in independent form. The Examiner acknowledges that the elements of these claims are not taught or suggested by the prior art.

However, the Examiner has rejected claims 1, 3, 5, 51, 53, 55, and 57 under 35 U.S.C. § 103(a) as being unpatentable over Applicant's Admitted Prior Art (AAPA). The Examiner argues that Applicant discloses that fuses having fuse elements of ternary In-Sn-Bi alloys were known in the fuse art at the time the invention was made. Specifically, JP 2001-266724 ("JP '724") allegedly teaches fuse elements with alloy compositions of 42 to 53% In, 40 to 46% Sn, and 7 to 12% Bi. The Examiner contends that since these ranges are overlapping with or close to the claimed ranges, it would have been obvious to one having ordinary skill in the art at the time of the invention to select ranges for ternary In-Sn-Bi alloys as claimed. That is, the Examiner concludes that one skilled in the art would have expected the claimed and prior art materials to have the same properties since the ranges are so close to each other. Regarding claim 5, the Examiner contends that the fuse element of JP '724 inherently contains inevitable impurities. Finally, regarding claims 51, 53, 55, and 57, JP '724 allegedly teaches that the fuse element is connected between a pair of lead conductors and sandwiched between insulating films. Applicant respectfully traverses this rejection and the arguments in support thereof as follows, and respectfully requests reconsideration and withdrawal of the rejection.

The present invention is directed to an alloy type thermal fuse and a fuse element containing a ternary alloy composition of 55 to 74 % In, 25 to 44 % Sn, and 1 to 20% Bi. Alloy type thermal fuses and fuse elements having the claimed elemental compositions were developed by Applicant as a result of intensive study in order to provide a fuse having a narrow operating temperature range and excellent overload and dielectric breakdown characteristics. In contrast with the claimed alloy composition, the alloy of JP '724 contains 42- 53% In, 40 – 46 % Sn, and 7 – 12% Bi. The alloy compositions according to the present invention and JP '724 are represented in the liquidus projections of Appendix 1 attached hereto.

As explained in the Background Section of the present application, in fuse elements having alloy compositions with a solid-liquid coexisting region (between the solidus and liquidus temperatures), there is a possibility that the fuse element will be fused off at an uncertain temperature in this region. A wide coexistence region thus results in a wide operating temperature range of the fuse. Conventionally, in order to reduce this dispersion of operating temperature, an alloy having a narrow solid-liquid coexistence region, and ideally a eutectic

composition, is utilized so that the fuse element fuses off at approximately the liquidus temperature (which is equal to the solidus temperature in a eutectic composition).

A variety of ternary Sn, In, Bi alloys are known. As shown in the liquid phase surface diagram in Appendix 2, attached hereto, these alloys have a binary eutectic point at 52In-48Sn (point E1) and a ternary eutectic point (point E2) at 21Sn-48In-31Bi. The binary eutectic curve which elongates from the binary eutectic point toward the ternary eutectic point passes through a region having 24-47% Sn, 50-47% In, and 0-28% Bi. However, alloy compositions in regions separated from the binary eutectic curve have wider solid-liquid coexistence regions, which may possibly widen an indefinite region of temperatures at which the fuse element fuses off and also increase the dispersion of the operating temperature of the thermal fuse. Accordingly, this region has not traditionally been investigated for suppressing the dispersion of operating temperature range by narrowing the solid-liquid coexistence region.

However, by studying a variety of Bi-Sn-In alloys having different compositions and measuring the DSC (differential scanning calorimetry) profiles thereof, Applicant has surprisingly found that when an alloy composition in a specific region which is separated from the binary eutectic curve is used as a fuse element, the resulting fuse element can be concentrically fused off in the vicinity of the maximum endothermic peak, and excellent overload and dielectric breakdown characteristics are thus obtained. Applicant has thus discovered a specific ternary In-Sn-Bi alloy composition, usable for a fuse element, which is suitable for environmental conservation and which provides excellent overload and dielectric breakdown characteristics and a narrow operating temperature range.

The alloy composition in this region, which is separated from the binary eutectic curve, has a wide liquid coexistence region and a single maximum endothermic peak. Accordingly, the dispersion of the operating temperature of the alloy thermal fuse may be controlled. Moreover, in the alloy composition, the total amount of In and Sn, which have a relatively smaller surface tension, is larger than the amount of Bi, which has a larger surface tension. Therefore, the wettability of the solid-liquid coexisting at the maximum endothermic peak is sufficiently improved even before the completion of liquidification, so that spheroid diversion of the thermal fuse element can be performed in the vicinity of the maximum endothermic peak. Consequently, the dispersion of the operating temperature of the thermal fuse can be reduced (and set to be within a range of ± 5° C). The holding temperature of such thermal fuses (20 °C less than the

operating temperature) may be less than or equal to the solidus temperature, which is desirable. Further, due to the relatively large percentages of In and Sn in the alloys, fuse elements having sufficient ductility to draw into thin wires, such as 200 to 300 μmφ, can be achieved.

The amount of In in the present alloys (55-74%) is removed from the binary eutectic curve (47-50%) by at least 5% and as much as 27%, which makes the solid-liquid coexistence region as wide as 16°C. That is, the In range of the claimed invention, which the Examiner contends to be "close" to the In range of JP '724, is actually not close at all, because the In range of JP '724 places the alloy on the binary eutectic curve, while the In range of the claimed alloy places it far removed from the binary eutectic curve.

Further, the total content of In and Sn, which have a relatively smaller surface tension, is larger than the content of Bi, having a larger surface tension. Therefore, the fuse element is divided in a wide solid-liquid coexisting state even during energizing and temperature rise, and the generation of an arc immediately after an operation may be satisfactorily suppressed. Due to the synergistic effects of arc suppression and reduced surface tension, physical destruction of the fuse is prevented, even in an overload test. Therefore, using the inventive fuses, insulation resistance after an operation can be maintained at a high level and excellent dielectric breakdown characteristics can be assured.

In contrast, in the alloy of JP '724, the concentration of In is on or in the vicinity of the binary eutectic curve, and the resulting alloy has a narrow solid-liquid coexistence region. When this region is narrow, the alloy during energizing and temperature rise is instantly changed from solid to liquid, which causes an arc to be generated easily during operation. The resulting local and sudden temperature rise causes vaporization of the flux and raises the internal pressure or chars the flux. In addition, the molten alloy or the charred flux is intensely scattered. Due to these occurrences, physical destruction, such as crack generation due to local and sudden internal pressure rise, or reconduction between charred flux portions, easily occurs during operation. Insulation distance is thus shortened and dielectric breakdown results.

Therefore, despite the fact that the Bi and Sn concentrations in the claimed alloy composition overlap with those taught by JP '724, the ternary alloy compositions are in fact dramatically different in properties due in part to the proximity of the JP '724 to the binary eutectic curve and the separation of the claimed alloy composition from this curve. Alloy compositions such as those taught by '724, which fall on or near the binary eutectic curve, do not

exhibit the unexpected properties of the claimed alloy fuses: a narrow operating temperature range and excellent overload and dielectric breakdown characteristics. Accordingly, the present invention would not have been obvious to one skilled in the art based on JP '724 or other Admitted Prior Art, and reconsideration and withdrawal of the § 103(a) rejection are respectfully requested.

Based on the preceding Remarks, Applicants respectfully submit that the pending claims are patentably distinct from the prior art of record and in condition for allowance. A Notice of Allowance is respectfully requested.

Respectfully submitted,

YOSHIAKI TANAKA

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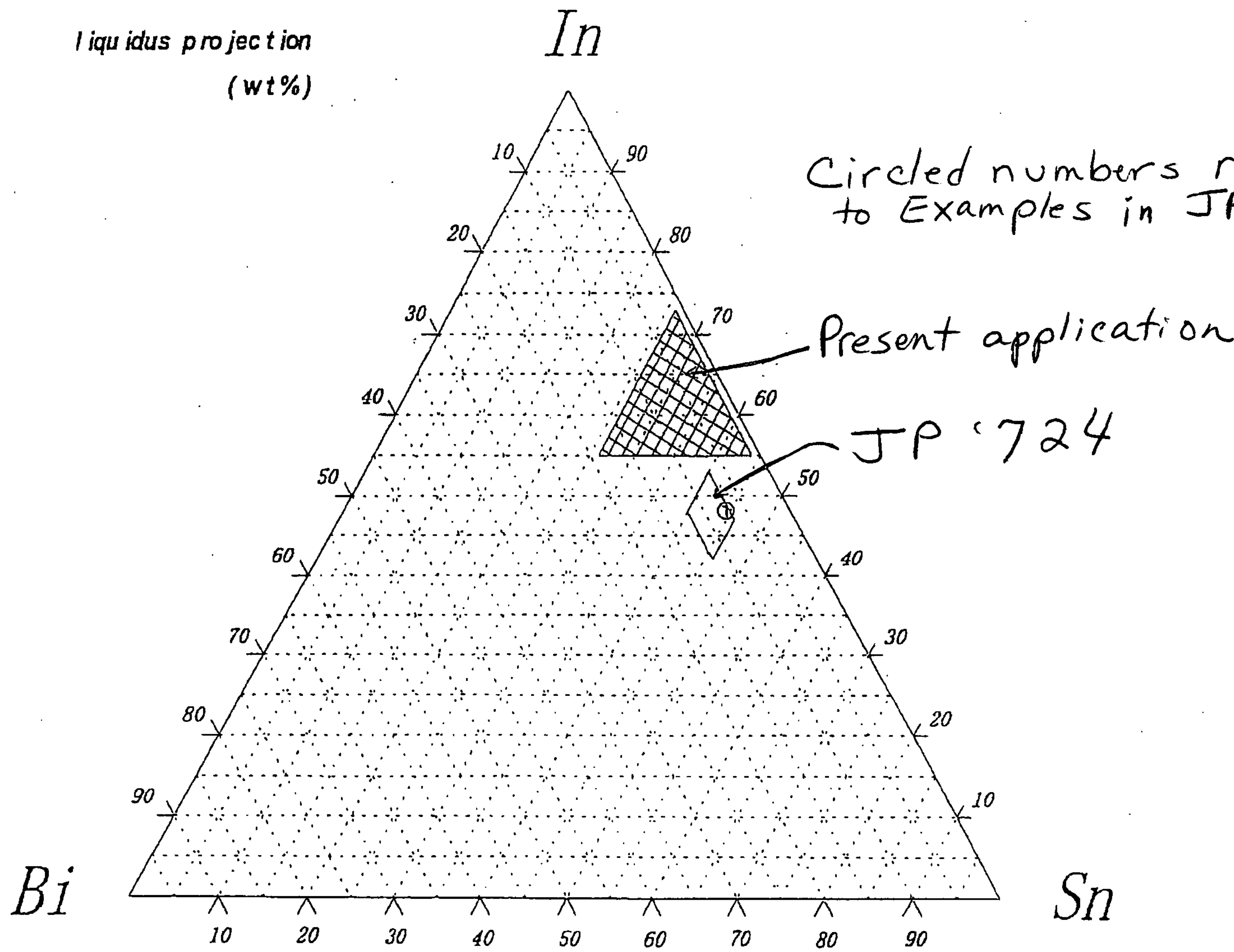
(Date)

SANDRA M. KATZ
Registration No. 51,864
AKIN GUMP STRAUSS HAUER & FELD LLP
One Commerce Square
2005 Market Street, Suite 2200
Philadelphia, PA 19103-7013
Telephone: 215-965-1200
Direct Dial: 215-965-1344
Facsimile: 215-965-1210
E-Mail: skatz@akingump.com

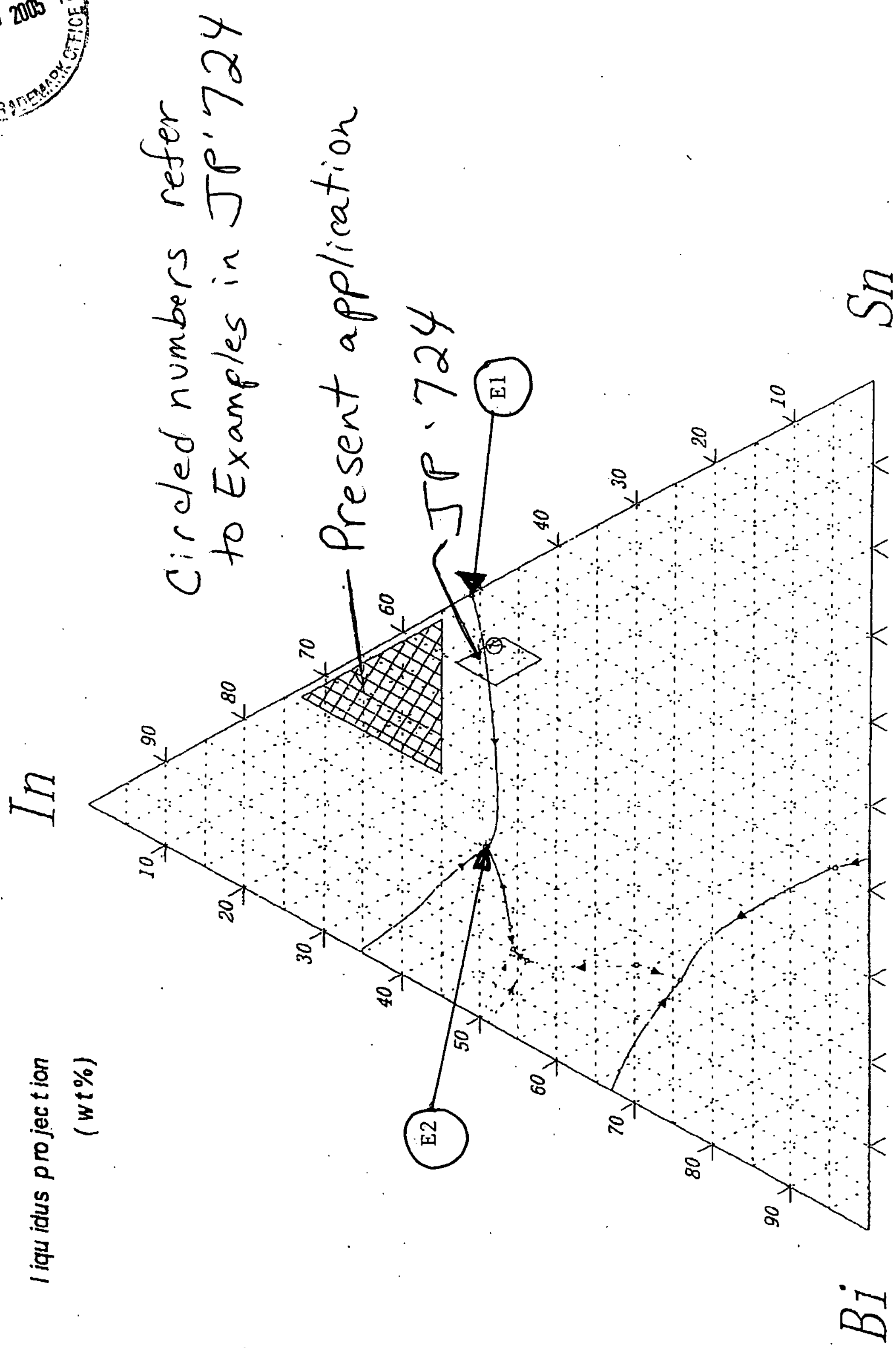
WWS/SMK:rc
Attachments: Appendices 1 and 2

Appendix 1

Circled numbers refer to Examples in JP'724



Appendix 2


Circled numbers refer to Examples in JP'724
Present application
JP'724
E1
E2
In
Sn
Bi
liquidus projection
(wt%)
10
20
30
40
50
60
70
80
90